Kilvington (S. S.)

Garbage Crematories

AND THE

DESTRUCTION OF

ORGANIC MATTER BY FIRE,

BY

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City of Minneapolis.

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GARBAGE CREMATORIES

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Destruction of Organic Matter by Fire.

BY SAMUEL S. KILVINGTON, M. D.,

PRESIDENT OF MINNEAPOLIS BOARD OF HEALTH.

The growth of great cities is the predominant feature of modern civilization. A necessary concomitant of their growth is the accumulation, in vast quantities and within a limited area, of the refuse of human life and the products of human death.

One of the most urgent problems, then, of municipal management, at the present day, is that of the sanitary disposal of waste matter. And the very rapidity of our urban development has left us far behind the average progress of our times in the solution of this difficult problem.

When cities were simply adult villages, few and far between, with their sparse population scattered over wide reaches of land, the question of the disposition of refuse could, if not with entire wisdom, at least with comparative safety, be left to take care of itself. Burial sufficed then to rid the living of their dead or to hide the debris with which men and animals overlaid the surface of the earth Slow growth and unlimited space gave time and room for the slow action of those chemic forces of the soil which decompose and disinfect its organic contents.

But with the appearance of great cities—the birth of an ardent and pregnant civilization—springing, like the ancient Titan, fullgrown from the bowels of the earth, this question takes on a new aspect. Amid dense populations and closely crowded dwellings, the opera-

tions of Nature's laboratory become injuriously tedious. We cling to the old crude methods of waste-disposal, or permit the accumulation of animal and vegetable deposits in the vicinity of our homes, only to find that the chemistry of Nature is inadequate for our protection and that even in the slow steps of her putrefactive processes she develops and introduces into the human economy the germs of disease. Nevertheless, we are slow to learn the lesson of the new order of things and still we permit the soil, and the air, and the water about us to be contaminated by human and animal dead; still we heap up, to our own destruction, the offscouring of our stables and our houses; still we poison the pure sources of our water supply with deposits of carrion, night-soil, garbage and manure. Future generations, could they unearth the strata of refuse with which our inhabitants of the past half century have overspread the sites of our cities or turn the rivers from their accustomed courses to view the waste material with which we have lined the beds of the streams, would surely be justified in denominating this the age of filth-formation.

But, happily, we are beginning to read with profit the lines of hard experience. For fifteen or twenty years the large cities of the Old and New World alike have been casting about for some satisfactory solution of the problem of waste disposal. Throughout this period many expedients have been devised, many new methods have been applied and, though we are still in the period of experimentation we are gradually gravitating toward the settlement of this sanitary question.

After all has been said and done in favor of all other means of ridding ourselves of the waste products of city life, history repeats itself in the suggestion of fire as the only competent agency at our command. I say history repeats itself in the suggestion of fire—for ancient civilizations and yet older pagan peoples long since, and again and yet again, arrived at the same sanitary conclusion to which we have come. Cremation of the human body, to say nothing of human waste, was in vogue among all early nations excepting those of Egypt, Judea and China. It was from the effete civilization of the latter country that Christian peoples derived the insanitary and inhuman practice of earth burial. In a great part of Asia and South America, the fire is still employed to destroy the remains of the dead and the refuse of the living. The method was followed by several North American tribes. Even the Israelites burned the bodies of Saul and his sons at Jabosh; the Jews cremated

the victims of the plague in the Vale of Tophet; and, outside the walls of Jerusalem, they cast their offal, garbage and dead animals into the unquenchable fire which burned perpetually in the pit of Gehenna, 3000 years ago. Cremation was practiced, undoubtedly, among the early Christians, while it was still resorted to by the Swiss in the eighth century.

The destruction of organic waste material by fire is the subject before us for discussion, and you observe that I take license from the breadth of the title bestowed upon my paper to include, incidentally, even the disposal of the dead by this sanitary method; for, though the classification of the remains of the beloved living with the unclean category of other organic and obnoxious materials is shocking to the affectional sense, the consequences of our prevailing custom of interment for those remains in large cities are as injurious as any similar disposition of any other decomposing matter we could make. Cremation must be the final end to which the organic products of human life and the organic products of human death must eventually come.

Sanitarians give no uncertain sound in their spoken recognition of the pressing needs of the situation and of the best method of satisfying those needs. Said Sir Henry Thompson, "No dead body is ever placed in the soil without contaminating the earth, the air and the water above and about it." Said Sir Robert Rawlinson, some four years ago: "The effectual destruction of refuse, at the least possible expense, is the object which must be attained." Says a recent issue of the *Sanitary Engineer*: "Next to pure water, there is nothing more important to a municipality than the satisfactory disposition of its refuse, and the two matters are often closely connected." And the eminent authority of London, to whom I have already referred, adds, in words quoted to this Association by my eminent predecessor upon this subject a year ago, "All matter liable to putrefaction must be consumed by fire!" Nothing, truly, but cremation will accomplish rapidly that which this putrefactive process does so slowly and, in its effects, so disastrously.

Having established the desirability of this destructive agent, we turn from the principle to the practical study of the apparatus by means of which it may be utilized. Open air destruction of refuse by fire constitutes an intolerable nuisance. It is essential that an enclosed and carefully constructed furnace chamber should be provided. The search after such a contrivance has been long and persistent and has led to variably successful results.

As early as 1865, the writer's appreciation of the importance of this question was stimulated, and his first practical ideas of a crematory were begotten, by his study of the furnace constructed at the Rock of Gibraltar for the purpose of disposing of the refuse accumulated by the garrison of that fort. It is believed that this crematory at the citadel on the straits was then the only furnace of the kind in public use.

In the year 1870 a firm of contractors in Paddington, England, attempted the design of a refuse destructor, which, when put into practical operation, proved a conspicuous failure. A few years later, Whiley, of Manchester, attempted a somewhat similar structure, with little better results. About 1875, the city of Manchester undertook to build a group of eight destructor furnaces. In contrast with the patents of later days they are crude in design, unsatisfactory in operation and expensive to support. Each furnace consumes less than five tons of material in twenty-four hours, and the entire plant employs not less than five men. Between 1881 and 1883, several Yorkshire towns became interested in the problem of garbage destruction by fire and the attention thus drawn to the subject by these and other cities led, in the five years following, to the issuance of a group of patents and the construction of as many garbage or refuse furnaces by a half dozen inventors.

As early as 1877, the city of Birmingham adopted the Fryer patent, a costly invention, so clumsily adapted to the purpose that it was speedily abandoned upon sanitary grounds. In 1881, the same furnace was remodelled and operated more successfully in Birmingham. About the same time was built at Byker, near Newcastle, England, a Fryer crematory, which cost the remarkable sum of thirty-three thousand, eight hundred and eighty dollars. A little later the Healey Patent Destructor was introduced in Bradford, England, and was built upon a plan which has since been followed and improved by other inventors. About the same period, the Wilkinson furnace superseded in effectiveness, without actually displacing, the Fryer patent at Birmingham and was erected also in the town of Blackpool. In 1885, Mr. Stafford, of Burnley, built his first Bee Hive Destructor at Richmond, England. Co-incidentally, a crematory upon the Hickey model was put up at Bengal, India, while another Bee-Hive furnace was erected in Bombay. Mess. Hewes, Hewes & Geary also built a crematory in Leicestershire, England, for the treatment of sewage sludge, and, at the same time, the great Glasgow plant, to which we shall again have occasion to

refer, was constructed. At this date, the evolution of a model refuse crematory seems to have reached a pause in its progress in Great Britain, to have passed over to the hither side of the Atlantic where the superior inventiveness and mechanical ingenuity of the American mind have brought it, within three years, to a point of perfection, coupled with a degree of simplicity in structure and economy of cost, which completely discount the more ponderous scientific efforts of our British brethren.

For, in 1885, Lieutenant Reilley, of the U. S. A., constructed for the U. S. post at Governor's Island, New York harbor, a miniature crematory, for the destruction of the refuse of the post, which proved to be the archetype of American furnaces. In the same year the Pittsburg gas companies offered the free use of natural gas to their city for the destruction of its refuse, and a small garbage furnace was built at Allegheny City, costing $1,500, in which this agent was used for fuel. Soon after our Canadian brethren took an active part in the solution of the problem, and Mr. William Mann, whose admirable crematory was so fully described to us at the last annual meeting of the Association by Dr. Laberge, the efficient health officer of Montreal, undertook the destruction of the night soil of Montreal at a cost of $8,000 per year to the city, while a year later he took the larger contract for burning its miscellaneous refuse for the sum of $43,000 per annum.

One after another, in the three succeeding years, came the estabment of crematories in the cities of the United States. First, the Bartlett furnace, a small crematory for use at John Hopkins Hospital, in Baltimore, was built. Then came the erection of the first crematory of the Engle patent at Des Moines, Ia., followed by the introduction of small furnaces upon this model in some of the colleges of that state. At the close of 1886, the Forrestal furnace was opened in Milwaukee. In 1887, Mr. M. F. Smith demonstrated the operation of a gas furnace, in Pittsburg, which would consume night soil and garbage in an astonishingly short space of time, but which seems to have been lacking in the essentials of sanitary protection. Within the same year, Pittsburg witnessed the erection of the Rider garbage furnace and Chicago selected the William Mann patent for its municipal use. In 1888, Detroit adopted the Glasgow Plant, while Buffalo adopted the Murtz system of disposing of a certain class of refuse, from which oil is extracted, and the residue of which is used as a fertilizer. And finally, Minneapolis, which I have the honor to represent, came to the front in the adop-

tion, with improvements, of the Engle patent, and her example, I am happy to say, has been followed by the city of Milwaukee in the choice of the model of the Minneapolis plant, which, in practical operation, we shall have an opportunity to present to you.

Other cities of prominence are carefully investigating the question of refuse destruction and are studying the different patents which offer themselves to the public.

It becomes of present and overshadowing importance, as we bring this history of the evolution of the crematory up to our own immediate day, to determine the relative merits of these patents, and, in order that this may be intelligently done, we should entertain clearly the qualities which they must necessarily possess for the fulfillment of metropolitan needs. A furnace, moderate in its cost of construction, economical in its needs of fuel, demanding a minimum of labor in its conduct, adapted to the varieties of waste material to be consumed, approximating a perfect and rapid destruction of such material, with practical freedom from all occasion of nuisance in the way of excess of smoke, the disposition of refuse, or the formation of noxious gases or offensive odors, and affording a product which will, at small cost of handling, prove remunerative and available for fertilizing or mechanical uses—this is the practical ideal that we seek.

I shall briefly discuss the leading features of the several patents now in conspicuous use, and endeavor to enable you to form some judgment of the greater or less measure in which they approach to that ideal. Three distinct methods of classification might be adopted—(1) that which turns upon the adaptation of the crematory to the destruction of certain definite kinds of refuse; (2) that which depends upon the provision for the immediate or the ultimate burning of the material; (3) that which is concerned with the means employed for the destruction of the smoke and offensive gases which result from the combustion of the material. I shall endeavor to assign to each of these patents its proper place under these several heads. Some of them I shall be compelled to pass over with but a few words of mention, either because they are not adapted, by the methods of their construction, to the needs of American city life, or because they are surpassed both in economy of construction and of operation by the later American models.

Among these may be noted the Healey Patent Destructor, built by the Municipal Appliances Company of London. It is designed for the burning of ordinary miscellaneous refuse and is not adapted

to the disposition of night soil. It is constructed upon the plan of an inclined grate and belongs therefore to the class of furnaces in which the garbage must be dried before descending into the fire. It is one of that class also in which a super-heated reverbatory arch is provided over the fire-grate, by means of which it is intended that smoke and noxious gases shall be consumed. The authorities of Bradford, where this furnace is in use, have found, however, that this end is not practically attained and that the offensive vapor issuing from the chimney flue constitutes a nuisance.

The Fryer furnace is altogether too costly for general adoption. It contains what is called a concretor, for the destruction of night soil, and a carbonizer for other refuse. The grate is formed upon the same general model as that of the Healy patent and the refuse, therefore, is dried and then burned. Its capacity, equally with that of the Wilkinson furnace, which we may also mention in passing, is small, and the cost of operation in both is relatively large. The Hewes, Hewes & Geary plant is a model of scientific construction, but its operation has not been practically demonstrated in this country. Unlike the furnaces to which we have already referred, whose product is only of value as a factor in the making of mortar, the Hewes, Hewes & Geary crematory produces a high quality of fertilizer, which is secured, however, at a cost too great to make its sale profitable in this part of the country.

The Glasgow plant is only in a limited sense a crematory. It really constitutes a station for the receipt, sorting, sale and distribution of refuse collected in a wonderfully systematic way, by the bucket system, from all parts of the city it serves. Animal manure and the more valuable kinds of miscellaneous refuse are not cremated at all. The cinders are sorted from the ashes collected and are economically used as fuel to feed the furnace fires, whilst the finer residue of the same is mixed with night soil and deodorized. A large quantity of this material is thus disposed of, and the product is mixed with the unburned refuse to form a fertilizer. The forms of refuse that are not available for fertilizing purposes are burned and the product of their combustion is ground up and used in mortar making. The Bee-Hive Crematory, patented by Mr. Stafford, of Burnley, is perhaps the most prominently and favorably known of any of the English models. As constructed at Richmond, England, it has a furnace in bee-hive form, situated upon each side of its chimney shaft. Each bee-hive is six feet in diameter, is built of fire-bricks, and is divided into three parts, vertically, by two tiers of

grate bars. Upon the lower rectangular tier of bars the fuel is received, while the refuse is thrown through the openings in the furnace dome upon the upper inclined grate. The Beehive belongs therefore to that class of furnaces which dry the refuse before burning it, while it carries the gases and smoke of combustion over, through conducting flues, from one bee-hive furnace to the other, passing the same over the fire and measurably consuming them. It is used for the destruction of garbage and miscellaneous refuse, and has a capacity of some fifteen tons a day. But a slight odor is discoverable in the smoke and vapor issuing from its chimney-shaft. The product of combustion is slacked and then ground up and used for making mortar. I am fortunate in being provided with illustrations of the Bee-Hive Crematory.

With pleasure I turn to the fuller descriptions, which I am able to afford, of the four principal crematories which have been in use during the last three years in the United States and Canada. The Forristal furnace, which has been operated until recently in the city of Milwaukee, consists of a two-story building. Teams drive into this building and dump their loads into a hopper, from whence it is carried by elevators into the drying room above. Here it is treated by steam heat and the liquid residue is drained off. It is then shoveled through a tubular chute to the floor below, where it is deposited in front of the furnace doors. Thence it is shoveled into the fire and kept constantly stirred. The fire itself is operated upon the principle of a blacksmith's forge with the aid of a blast fan. The latter, together with the refuse elevators, is run by a small steam engine, which also furnishes steam for the drying room. The furnace is of brick, with a square form and an arched top. It maintains a single fire, which is re-lighted every day. A single row of doors, upon each side of the furnace, serves for the admission of fuel, for the supply of refuse and for the work of stirring or stoking the fire. Smoke and gases are carried out directly into the chimney shaft. An engineer and four laborers are required to run the plant. To sum up, the Forristal crematory is designed for the destruction of miscellaneous refuse; it is not adapted to the disposal of night soil; it has a single fire which directly consumes the waste material, but it has no special provision for destroying smoke and gases.

The Rider garbage furnace is, as we have already said, in use in the city of Pittsburg. It has been largely used in that city for the destruction of spent tan bark and has performed this task, as also that of the destruction of garbage, to the apparent satisfaction of its own-

ers and the public. Its construction seems to require the primary investment of a large sum, but its patentee claims, as one of its most desirable features, great economy in the expenditure of fuel. It is said to require an amount of fuel equal to less than five per cent. of the material cremated, this being used as an initial supply to bring all parts of the furnace to a proper temperature, after which, it is claimed that the garbage itself, if furnished in sufficient quantity, will provide all the fuel necessary to maintain its operation. It is needless to say that this must depend, in any furnace, upon the degree of combustibility of the refuse matter discharged into it as also upon the disposition which is made, throughout the whole extent of the furnace, of these fuel-forming materials.

The Rider furnace is of an elongated form. It consists of a front chamber, 12½ feet in length by 6 feet 5 inches in width. This chamber is surmounted by a dome in which are eight circular openings 15 inches in diameter. In the rear of this is another chamber, 9½ feet in length by the same width, which is floored with a tile hearth. This is separated from the first chamber by a bridge wall, three feet in thickness, and has in its rear a second bridge wall over which the products of combustion pass to enter the chimney. This second chamber is also surmounted by a dome in which are six circular openings the same size as the first. The products of combustion in this furnace are said to be completely innocuous, while the solid residuum is valuable as a fertilizer. This crematory, then, belongs to that class which can be adapted to the destruction of excreta as well as miscellaneous refuse. It disposes of its supply by immediate and direct combustion, and, although no special means are provided for the consumption of smoke and gaseous products, experience with it, up to the present date, would indicate its freedom from any objectionable or insanitary features.

After the remarkably complete description of the Mann crematory to which this association listened a year since, it is hardly necessary that I should go at length into the details of its construction. Like others of its class, it can be adapted in form and size to the location it occupies and the needs of the community it is intended to serve. It shares with the Engle patent, the beauty of simplicity of structure. As built in Montreal, where its operation is reported to be very satisfactory, its combustion chamber is quadrilateral, with dimensions sixteen feet long by nine feet broad and ten feet high. This is fitted with a grate, of approximately the same dimensions, which is laid with a slight incline upward in the direction of the

chimney flue. At the lower end of this grate is its single fire-place. It has upon each side of it, three tiers of three doors each; the upper tier are at the level of a staging floor, upon which the loaded refuse carts are driven, the refuse being emptied directly into the furnace through these doors, or placed upon the floor in front of them. The second tier of openings is situated just above the line of the grate and these are used for stirring the fire. The lowest tier is at the level of the ash-pit, and gives opportunity for the removal of the ashes. The grate bars are laid two inches apart.

In Montreal two forms of the Mann furnace are in operation, one for the destruction of miscellaneous refuse; the other for the burning of night soil. There, as in Chicago, where the same furnace is used, the smoke emitted has not amounted to a nuisance, nor has any perceptible odor been noticed from either excepting during the cremation of chicken feathers.

In conclusion, let me invite your attention briefly to the only remaining patent left for our discussion the Engle crematory; an invention which has demonstrated, or is demonstrating, its own success in the cities of Minneapolis, Des Moines, Coney Island and Milwaukee. As constructed in the city of Minneapolis and duplicated here in the city of Milwaukee, we have an elongated arch furnace. Its cremating chamber is thirty-three feet long by five feet wide. It has a height of arch from the grate to the dome of seven feet clear. At the end of this grate nearest to the chimney flues, but not in connection therewith, is the primary fire-place. Beneath the grate, throughout the whole length, is an elongated ash-pit which is floored with fire-clay tiles and which forms the roof of a super-heated smoke-flue which I shall presently describe. At the end of the furnace most remote from the chimney shaft is a fire grate, four feet below the level of the first, upon which a secondary fire burns. Between this and the chimney shaft runs the long horizontal smoke flue, to which I have already referred, with its super-heated tiled roof, continuing for a length of 28 feet to the chimney shaft which rises 100 feet in height. The building in which the furnace is enclosed is of three stories. At the level of the first floor is a double row of doors, the upper of which give opportunity for feeding the primary fire and for stoking the burning material, while the lower open into the ash-pit, and permit the removal of ashes. At the farther end of the furnace, upon this same floor, are doors for supplying the secondary fire and removing any ashes it may produce. The second floor is at the level

of the top of the brick furnace, and upon this floor are delivered the bodies of dead animals, which, by means of pully attachments, are lowered through a large tubular shaft rising to the level of this story and discharging into the furnace at a point near the primary fire. To the level of the third story rise from the furnace dome three tubular shafts, fifteen feet in length, into which the misellaneous refuse wagons immediately discharge their contents from the upper floor upon which they drive. Preparatory to the operation of the furnace, fires are started in the primary and secondary fire-places and are maintained until a sufficient degree of heat prevails throughout the furnace and in the super-heating-flue beneath the ash-pit. I have already emphasized the fact that animals are discharged into the furnace nearest the primary fire, whilst other miscellaneous material is distributed through the smaller tubular flues along the remoter portions of the grate. This arrangement contributes, to the aid of the primary fire, the best fuel-forming materials to be burned first, thus diminishing the amount of fuel required to maintain the action of the furnace. The gaseous products of combustion are carried over the grate and thence over the secondary fire, burning at a lower level at the opposite end, and are there consumed; thence any small amount of remaining smoke or gas is carried along through the super-heated horizontal flue, undergoing further combustion, until the chimney-shaft is reached. The ashes or the debris, falling through the bars of the grate, light upon the fire-tiled floor of the ash pit, where they are again consumed; while liquids, dropping upon it, are instantly evaporated; thereupon also the final ashes are deposited. The arrangement by which the scavengers dump directly into the flues minimizes labor and insures greater cleanliness.

Among the questions likely to be asked under this topic, is that which relates to the primary cost of construction. Definite answers to this query cannot be given, for the reason that, with any one of the furnaces we have described, cost must depend very largely upon location, availability of materials, command of skilled labor, and the size and capacity of the furnace which the circumstances and extent of the population demand. Equally important is the question of the cost of operation. This again is insusceptible of a definite reply. Location, available fuel-supply, economical management of the furnace fires, the class of garbage or refuse to be burned, and the proper disposition of fuel-forming materials—these are all considerations which largely affect the question of working cost. The Mann furnace in Montreal is said to be operated at a cost of 25 cents per

ton of miscellaneous refuse and of 75 cents per ton of night soil. It is claimed that the Rider furnace will do about the same thing.

An estimate of the expenses of operating the Engle crematory in Minneapolis for a period of five days, during which the furnace was worked by three men entirely new to the task, two of whom were on duty by day and one by night, gives the following facts and figures:

CONSUMED IN FIVE DAYS.

Thirty-three horses, 59 dogs, 103 barrels of hotel and commission house refuse, 12 loads market offal, 70 loads manure, weighing in all over 200 tons.

Total cost of labor and fuel for this period $38.25 or $7.65 per day, the entire weight of refuse being destroyed at a cost of 19 cents per ton. The ash deposited in the course of the consumption of this material is exceedingly small in quantity, weighing less than 200 pounds per day.

This estimate, eminently satisfactory as it is, is not altogether a fair one. The men employed were wholly inexperienced. The furnace at the beginning of these five days was cold, and it required several hours to superheat it. The fuel used was simply lath edgings and coal screenings, or "breeze." The glut of horses was unusual and crowded out the ordinary supply of garbage. It is safe to say that upon an average run, over an extended period, 15 to 20 cents per ton of refuse would pay for the labor employed and the fuel consumed.

So far then as a brief period of time has permitted careful observation, the principal American crematories may be said to have demonstrated their fitness for the task of waste destruction. The possibility of burning the refuse materials of a great city, without imposing upon its people a penalty of insanitary consequences in the performance of the act, has been established beyond the shadow of a doubt. Nuisance is far more apt to arise from mismanagement in the handling of the material to be burned than it is likely to ensue from the products of cremation. The odors which arise from the direct burning of night soil, even without any special precaution for the consumption of gases formed, are not so obnoxious as might be imagined, resembling the smell of burnt leather. The commercial value of the solid residue of combustion has yet to be tested. It will vary, of course, according to the method of cremation. The innocuous character of the ash must be demonstrated in each individual case. The only analysis of this material, as produced by the Minne-

apolis crematory, that I have had an opportunity to obtain, has been made within a few days past by Prof. James A. Dodge, professor of chemistry in the Minnesota State University. The sample which he examined was selected in small quantities from different parts of the ash-pit, but it was taken therefrom within a few hours of the initial starting of the furnace, and before the ash-pit had become thoroughly super-heated; consequently it may be assumed that it contains some proportion of organic matter which would be consumed under more average circumstances.

The following is the report of the analysis made to me by Prof. Dodge:

"I hereby report to you the results of my analysis of a sample of ashes lately received from you.

ANALYSIS.

	Per cent.
Moisture	2.82
Organic matter	10.68
Sand and clay	49.19
Sodium chloride	2.83
Iron	1.96
Lime, CAO	10.26
Magnesia, MGO	.78
Potassa, K_2O	2.68
Soda, MA_2O	2.57
Anhydrous phosphoric acid, P_2O_5	8.16
Anhydrous carbonic acid, CO_2	1.49
Soluble silica, SO_2	1.24
Sulphur in sulphates and sulphides	1.59
Oxygen, combined with part of the iron and part of the sulphur, and loss	3.75
	100.00

I append the following notes on the foregoing analysis:

The organic matter is partly unburned carbon and partly nitrogenous matter communicating considerable odor to the ashes. The iron is probably mostly in the state of oxide of iron, but partly in the state of sulphide of iron; the latter gives some odor. The lime and magnesia are mostly combined with the phosphoric acid, making about 18 per cent. of phosphates of lime and magnesia. The potassa is mostly combined with carbonic acid. The soda is probably combined partly with carbonic acid. The silica is probably combined with soda and some potassa. The sulphur probably exists mostly in sulphate of lime.

The precise manner and proportion in which the above bases and acids are combined cannot be determined."

Very respectfully yours,

JAMES A. DODGE, *Prof. of Chemistry.*

It will be seen that this ash contains many constituent elements which make it of some value as a fertilizer. The product of any such furnace, employed in the destruction of animal and vegetable refuse, would be enhanced in value by the admixture of the product of a night soil crematory. This fact is illustrated by the management of the Glasgow plant. I have at hand samples of the ash of the Engle crematory at Minneapolis, which I shall be happy to submit either to the olfactory organs or to the chemical retorts of the members.

After the most minute description of the several crematory patents, that the limits of such a paper as this will permit, has been made, the choice of a furnace remains a difficult one. It lies unquestionably, for American cities, between the Rider, the Mann and the Engel patents. Each of these have their features of advantage. After a careful study of the subject, Minneapolis and Milwaukee have, as you are aware, determined upon the Engel crematory, with certain modifications. And after a careful selection has been made, an equally important duty remains A furnace should never be built from mere designs or drawings, or even under the charge of an ordinary architect or builder. The supervision of the work by a specially trained person should be secured, or it will inevitably follow that mistakes will be made and money foolishly expended.

But I must hasten to a close. The summation of facts I have had the pleasure to lay before you, must give to every sanitarian among us a sense of self-congratulation that he has fallen upon such a period of progress in this direction and has the opportunity of hastening the steps of this reform. Everywhere interest in the question of cremation is awakening, and the present points to a future—a *near* future—in which every city, large or small, upon the American continent, will consider the crematory a necessary part of its municipal outfit. And not only is it given to each of us to look forward to a time when our cities will be redeemed from the curse of accumulating waste, when the rivers will be unpolluted by the sewage which now converts them into common sewers, when the cess-vault and the garbage pit and the manure heap and even the earth cemetery will be abandoned, when the age of filth formation will be superseded by the era of filth destruction, when fire will purify alike the refuse of the living and the remains of the dead,—but also is it allotted to each one of us to help to bring in the coming of this sanitary consummation.